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2024 TRANSPORTATION SYMPOSIUM

FHWA Proven Safety Countermeasures



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28 Proven Safety Countermeasures

Source: FHWA

Speed Management



[Appropriate Speed Limits for All Road Users](#)



[Speed Safety Cameras](#)



[Variable Speed Limits](#)

Roadway Departure



[Enhanced Delineation for Horizontal Curves](#)



[Longitudinal Rumble Strips and Stripes on Two-Lane Roads](#)



[Median Barriers](#)



[Roadside Design Improvements at Curves](#)



[SafetyEdgeSM](#)



[Wider Edge Lines](#)

Intersections



[Backplates with Retroreflective Borders](#)



[Corridor Access Management](#)



[Dedicated Left- and Right-Turn Lanes at Intersections](#)



[Reduced Left-Turn Conflict Intersections](#)



[Roundabouts](#)



[Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections](#)



[Yellow Change Intervals](#)

Pedestrian/Bicyclist



[Bicycle Lanes](#)



[Crosswalk Visibility Enhancements](#)



[Leading Pedestrian Interval](#)



[Medians and Pedestrian Refuge Islands in Urban and Suburban Areas](#)



[Pedestrian Hybrid Beacons](#)



[Rectangular Rapid Flashing Beacons \(RRFB\)](#)



[Road Diets \(Roadway Configuration\)](#)



[Walkways](#)

Crosscutting



[Lighting](#)



[Local Road Safety Plans](#)



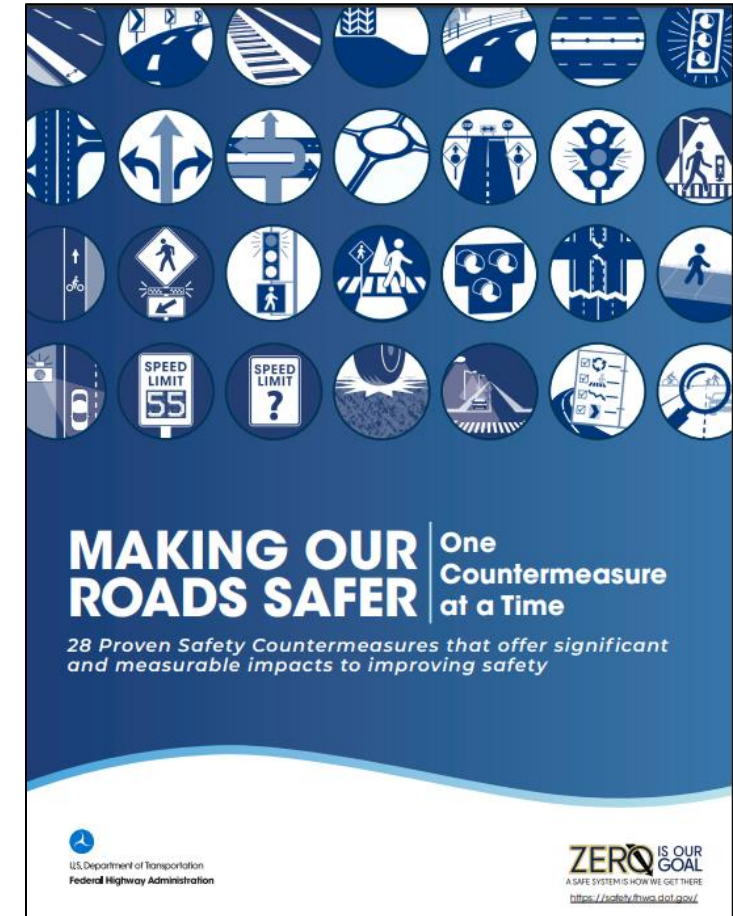
[Pavement Friction Management](#)



[Road Safety Audit](#)

History of the Proven Safety Countermeasure initiative (PSCi)

- Version 1 debuted in 2008
 - Envisioned as a means to boost systemic implementation
 - Debuted with 9 “proven safety countermeasures”
- Version 2 released in 2012
 - Made updates and added five new countermeasures for a total of 14
- Version 3 released in 2017
 - Added six new countermeasures for a total of 20
 - Developed informational one-pagers and a booklet
- Version 4 released in 2021
 - Added eight new countermeasures and updated one for a total of 28
 - Enhanced functionality of webpages and updated all one-pagers



Source: FHWA

Proven =

- ↳ Comprehensive literature and Clearinghouse review
- ↳ Effectiveness in reducing fatalities and serious injuries
- ↳ Supported by data and research
 - High-quality Crash Modification Factors (CMFs) - 4 and 5 stars
 - Extensively studied and documented

WHAT IS A CRASH MODIFICATION FACTOR (CMF)?

A CMF is an estimate used to quantify the change in crashes expected after the implementation of a countermeasure and whether it will result in a decrease in crashes (CMF below 1.0), an increase in crashes (CMF over 1.0), or no change in crashes (CMF of 1.0).

Example

CMF = 0.8 or 20% reduction in crashes

CMF = 1.07 or 7% increase in crashes

PSCs - Recognized and Supported

➤ SME input

- Leading national implementation
- Peer Exchanges
- Technical Assistance
- Committee and Council involvement

➤ NTSB Recommendations

➤ NRSS Action Items

➤ Stakeholder input

➤ Complement NHTSA's *Countermeasures that Work*

U.S. Department of Transportation

ABOUT DOT ▾ PRIORITIES ▾ CONNECT ▾

National Roadway Safety Strategy Home

Call to Action >

Implementing NRSS

The Roadway Safety Problem

Safe System Approach >

Overview

Safer People

Safer Roads

Safer Vehicles

Safer Speeds

Post-Crash Care

How does safety impact U.S. DOT's work in other priority areas?

Related Links

- [Read the U.S. DOT National Roadway Safety Strategy](#)
- [NRSS Dashboard: Safer Roads](#)
- [FHWA's Proven Safety Countermeasures](#)

Safer Roads

Design roadway environments to mitigate human mistakes and account for injury tolerances, to encourage safer behaviors, and to facilitate safe travel by the most vulnerable users.

Roadway design strongly influences how people use roadways. The environment around the roadway system—including land use and the intersections of highways, roads, and streets with other transportation modes such as rail and transit—also shapes the safety risks borne by the traveling public.

U.S. DOT has advanced an initiative to develop a growing collection of [Proven Safety Countermeasures](#) effective strategies to reduce fatalities and serious injuries on our Nation's roadways.

Transportation agencies are strongly encouraged to consider widespread implementation accelerate the achievement of local, State, Tribal, and National safety goals. These strategies apply to all types of roads—from rural to urban, from high-volume freeways to less and county roads, from signalized crossings to horizontal curves, and everything in between.

Proven Safety Countermeasures

The [Proven Safety Countermeasures](#) initiative is a collection of countermeasures and strategies to reduce roadway fatalities and serious injuries on our Nation's highways.

Four sample countermeasures improve pedestrian, cyclist, and rural roadway safety:

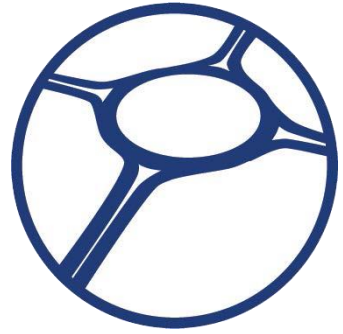
- Crosswalk Visibility Enhancements**
[Crosswalk visibility enhancements](#)—lighting, signing and pavement markings—can greatly reduce pedestrian crashes.
- Medians and Pedestrian Refuge Islands**
[Medians and pedestrian refuge islands](#) can reduce pedestrian crashes by 10 percent.
- Bicycle Lanes**
Separated [bicycle lanes](#) can reduce crashes up to 49 percent on rural roads as well as local roads.
- Rumble Strips**
[Rumble strips](#) can reduce head-on fatal and injury crashes by as much as 64 percent on the center line of two-lane rural roads.

Safer Speeds

Action	Lead(s)	Action Type	Target Completion
Update and lead the implementation of a robust, multimodal speed management program through new guides and close partnerships with stakeholders.	FHWA NHTSA	Program Oversight	2024
Develop and improve the information available for setting speed limits through Proven Safety Countermeasures and the Manual of Uniform Traffic Control Devices, providing a range of methodologies depending on the context of the roadway. Clarify the applicability and correct use of key criteria used in setting speed limits such as the 85th percentile. Provide technical assistance to all sizes of communities to determine appropriate speed limit setting, considering external assistance from leading practitioners and research organizations.	FHWA	Guidance	2024
Revise FHWA guidance and regulations to take into account the safety of all users by encouraging the setting of context-appropriate speed limits and creating roadways that help to "self-enforce" speed limits. Provide noteworthy practices for re-engineering roads to slow down vehicles rather than relying primarily on enforcement to manage speeding. Promote speed safety cameras as a proven safety countermeasure .	FHWA	Guidance	2024
Make funds available to communities through discretionary grant programs such as the Safe Streets and Roads for All program, and through behavioral safety programs to study and pilot automated or enforcement strategies focused on speeding that are designed to ensure their equitable application.	FHWA NHTSA	Program Oversight	2024

Source: USDOT

Potential for Widespread Deployment



- **Over 15 million intersections**
- **300,000 are signalized**
- **Only 10,000 roundabouts**
- **Up to 82% reduction in fatal and injury crashes**



- **2,850,000 miles of paved roadways**
- **Only 600 miles of separated bike lanes**
- **Converting traditional bike lane to separated bike lane - up to 53% reduction in bicycle/vehicle crashes**



- **Over 10 million curves on 2-lane roads**
- **21 states with 10 or fewer HFST locations**
- **Only 3 states with CPFM programs**
- **Up to 48% reduction in injury crashes**

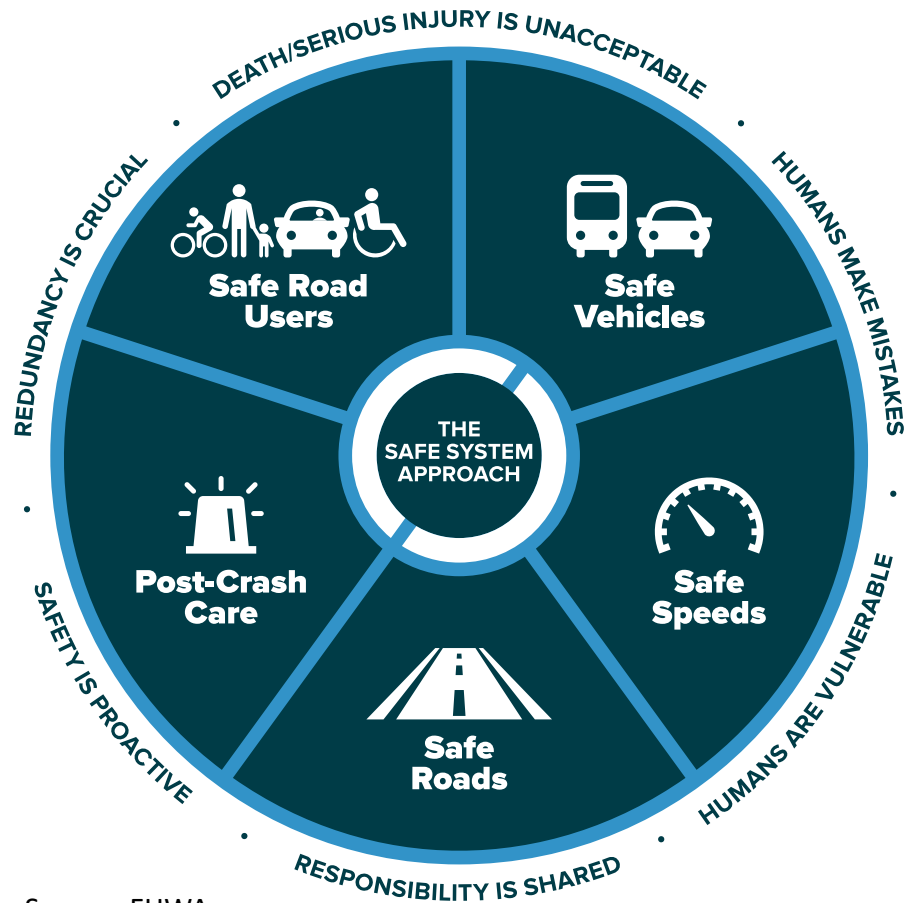


- **25 states and D.C have state law or city ordinance permitting SSCs**
- **19,000 school districts (over 129,000 schools) in the US**
- **Only 220 individual communities with SSC programs**
- **Up to 37% reduction in fatal crashes**



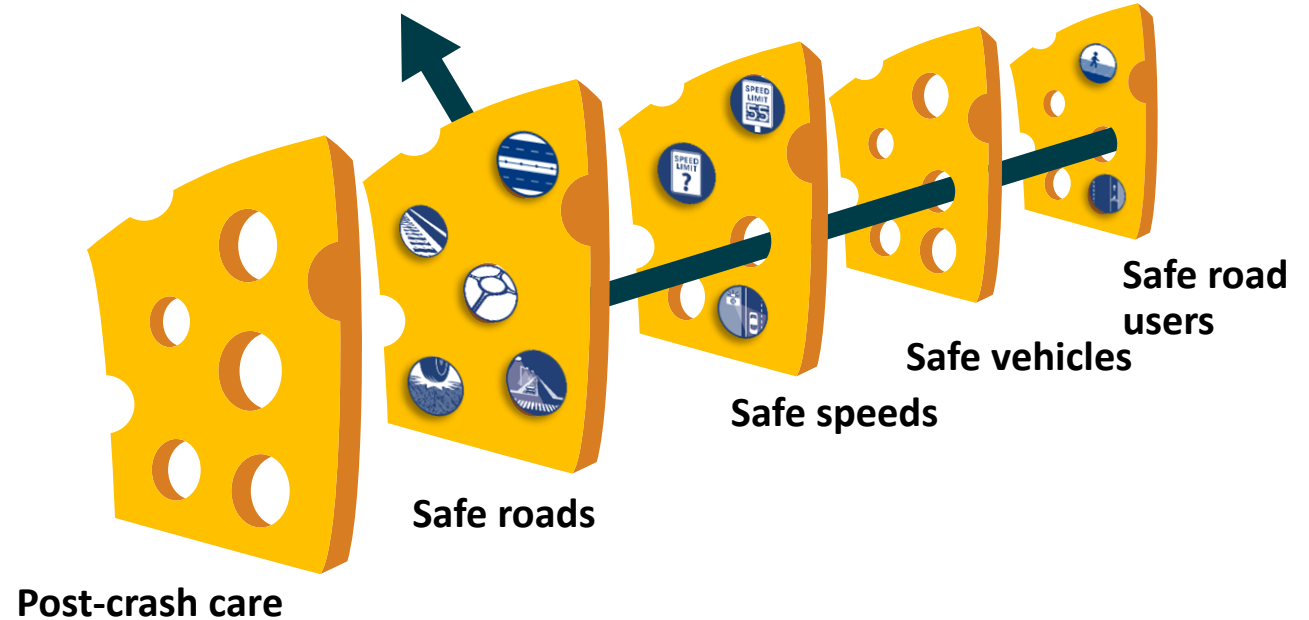
- **Over 35,000 projects awarded from BIL**
- **29 State DOTs conduct only 1-10 RSAs per year, 6 State DOTs do not conduct RSAs**
- **Up to 60% reduction in total crashes**

PSCs Support the Safe System Approach



Source: FHWA

The “Swiss Cheese Model” of redundancy creates layers of protection



Adapted from James Reason's model for analyzing accident causation
<https://royalsocietypublishing.org/doi/10.1098/rstb.1990.0090>

PSC Summary Table Information

Safe System Roadway Design Hierarchy Alignment

- Remove Severe Conflicts - Eliminating specific high-risk conditions, such as separating road users moving at different speeds or different directions in space to minimize conflicts.
- Reduce Vehicle Speeds - Implementing design features and speed management strategies to reduce vehicle speeds; effectively reduces the kinetic energy involved in a crash should it occur.
- Manage Conflicts in Time - Separating the users in time using traffic control devices, such as traffic signals or hybrid beacons, to minimize vehicle conflicts with vulnerable road users.
- Increase Attentiveness and Awareness - Alerting roadway users to certain types of conflicts so that appropriate action can be taken.

Cost Ranges

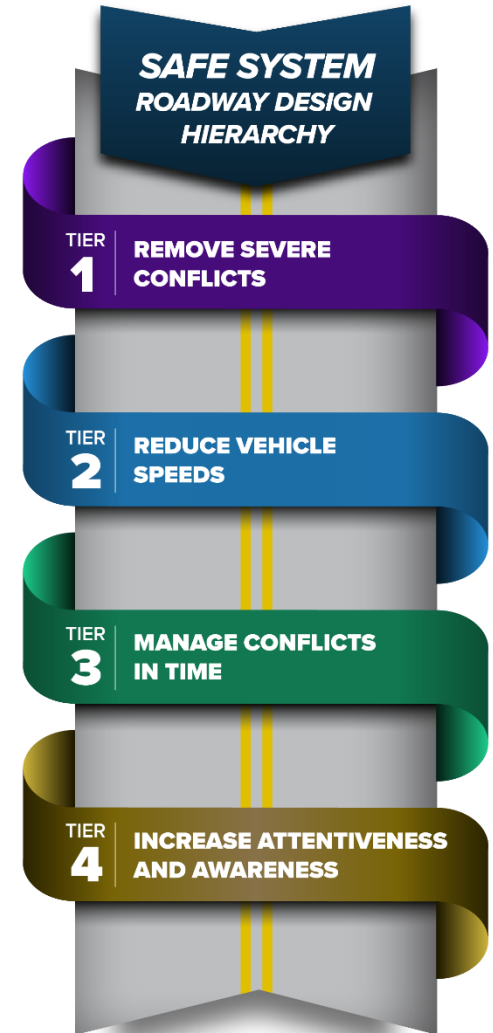
- Low-cost (L) – up to \$5,000 per mile or per curve/location.
- Medium-cost (M) – \$5,000 to \$50,000 per mile or per curve/location
- High-cost (H) – More than \$50,000 per mile or per curve/location.

Crash Reduction

- Low (L) = greater than 0% and less than 25% reduction.
- Medium (M) = greater than 25% and less than 50% reduction.
- High (H) = greater than 50% reduction.

Typical Service Life

- “the number of years in which the countermeasure is expected to have a noticeable and quantifiable effect on the crash occurrence at the site.” (HSM)
- See FHWA Countermeasure Service Life Guide



Source: FHWA

PSCs – Speed Management



Appropriate Speed Limits for All Road Users



Speed Safety Cameras (SSC)



Variable Speed Limits (VSL)



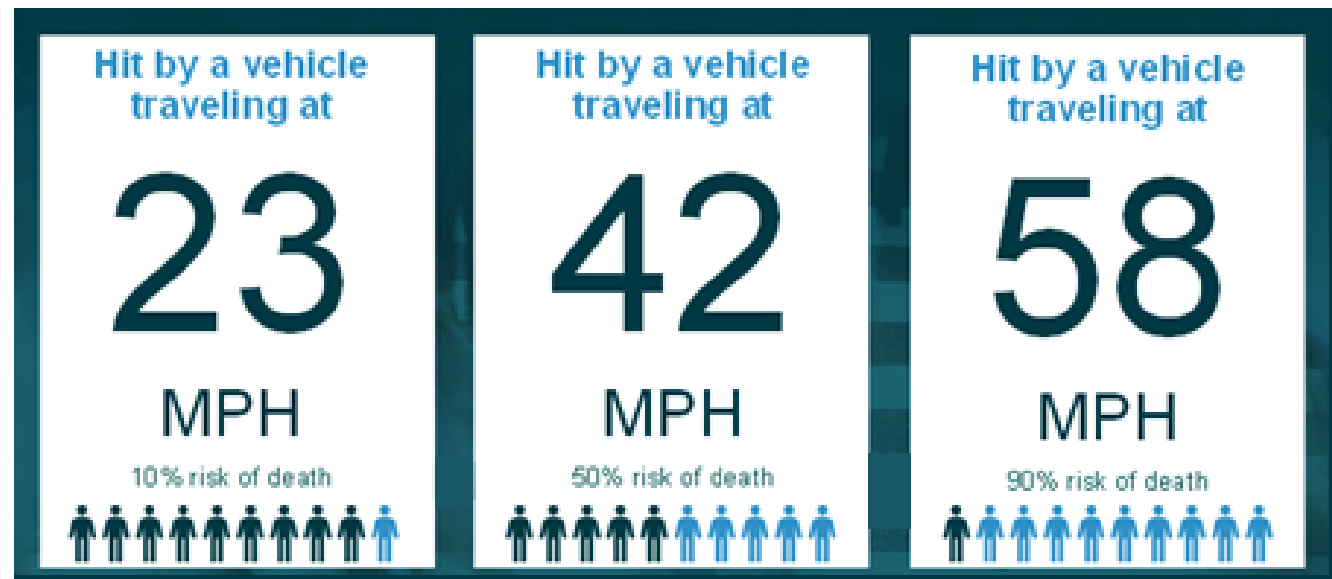
Appropriate Speed Limits for All Road Users



Appropriate Speed Limits for All Road Users



- Setting appropriate speed limits and achieving safe speeds can reduce the risks for all road users.
- Inappropriate speed in urban settings can be deadly for vulnerable road users who frequently share space with vehicles.



Source: FHWA

Appropriate Speed Limits for All Road Users

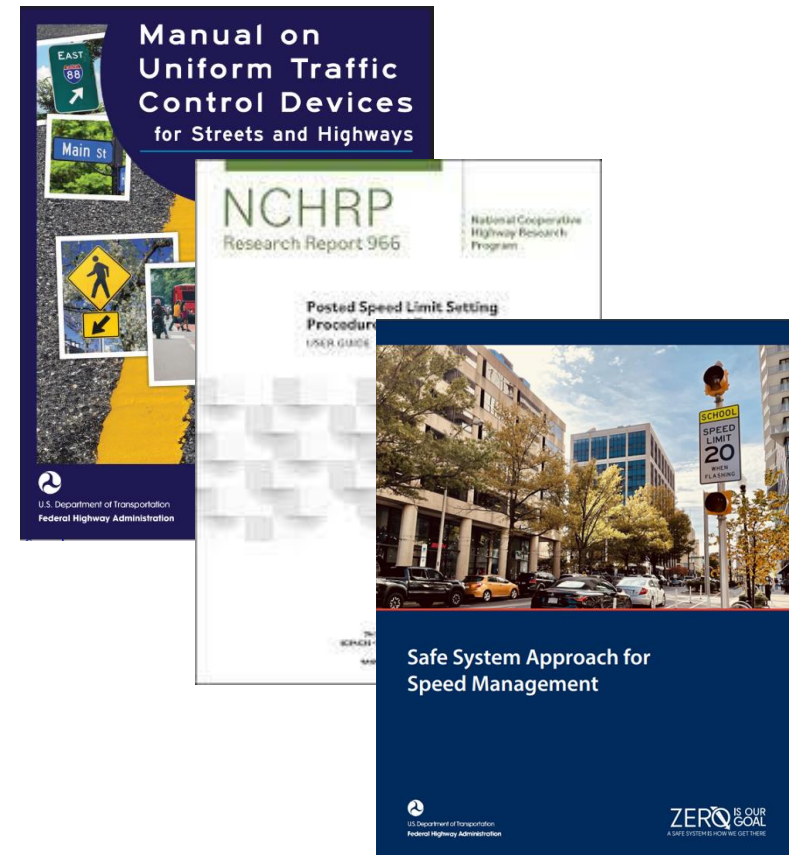


Applications

- Legislative Statutory Speed Limits
- Non-Statutory Speed Limits / Speed Zones
 - MUTCD
 - *Speed Limit Setting Handbook (end of 2024)*
 - Expert Systems Tools
 - Safe System Approach / Injury Minimization

Considerations

- Target Speed
- Range of factors
- Speed limit setting to be used with other speed management strategies



Source: FHWA, TRB



- City of Seattle implemented 20 mph speed limits on all non-arterial streets and 25 mph for over 400 miles of arterial streets – **26% reduction** in fatal crashes
- Setting a lower speed limit and other speed management strategies - up to **40% reduction** for fatal and injury crashes (CMF ID 10249)



Source: FHWA

Speed Safety Cameras



Speed Safety Cameras (SSC)



Applications

- Fixed units
- Mobile units
- Point to Point (average speed) units

Considerations

- Conduct legal and policy review to determine if SSCs are authorized within a jurisdiction
- Public trust is essential
- On-going evaluation of safety effectiveness and public acceptance



Source: FHWA

Effectiveness



Fixed-point units:

- Up to **54% reduction** for all crashes (CMF ID 2915)
- Up to **47% reduction** for injury crashes (CMF ID 2921)
- **63% reduction** in speeding during school hours (New York City)

Point to Point (P2P) units:

- Up to **37% reduction** for fatal and injury crashes (CMF ID 7718)

Mobile units:

- Up to **20% reduction** for fatal and injury crashes (CMF ID 7582)

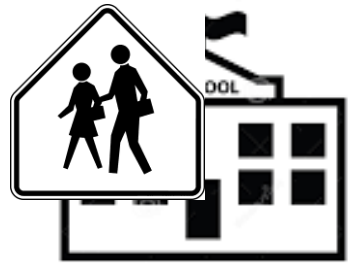


Source: Vision Zero Network

Opportunity for Widespread Deployment



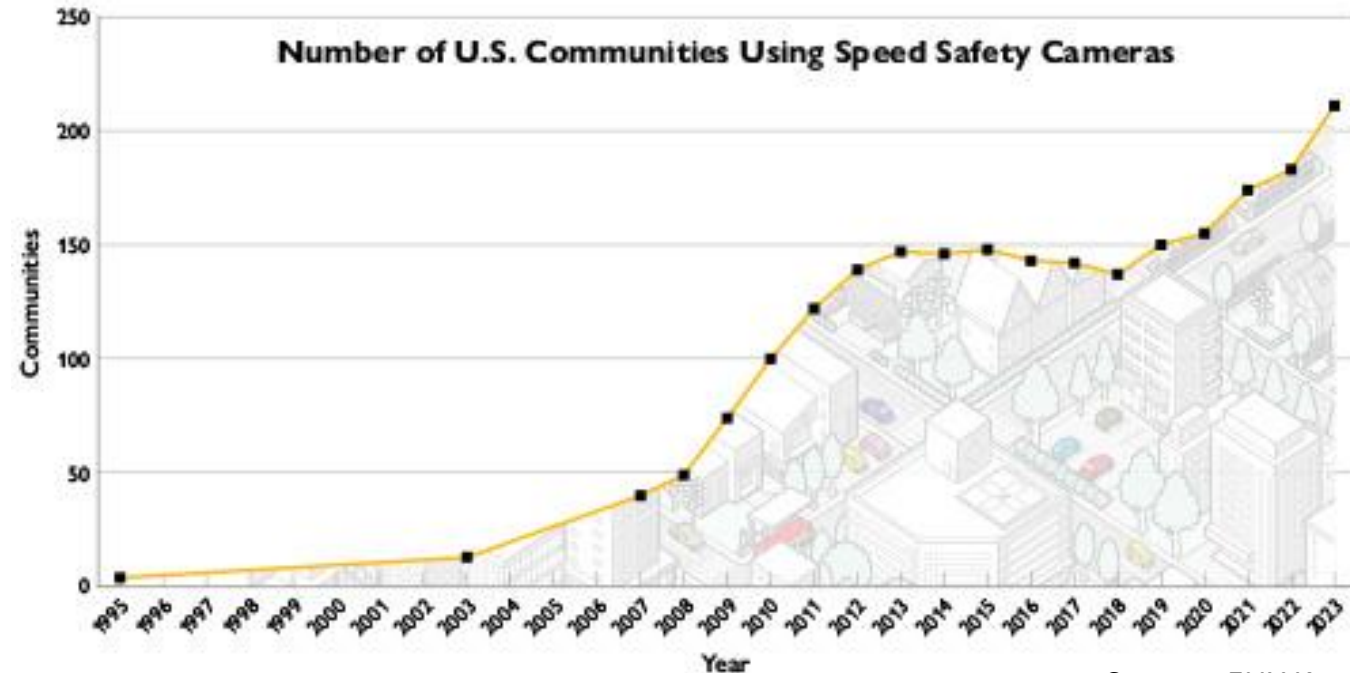
25 states and D.C have state law or city ordinance permitting SSCs



19,000 school districts (over 129,000 schools) in the US



Only **220** individual communities with SSC programs



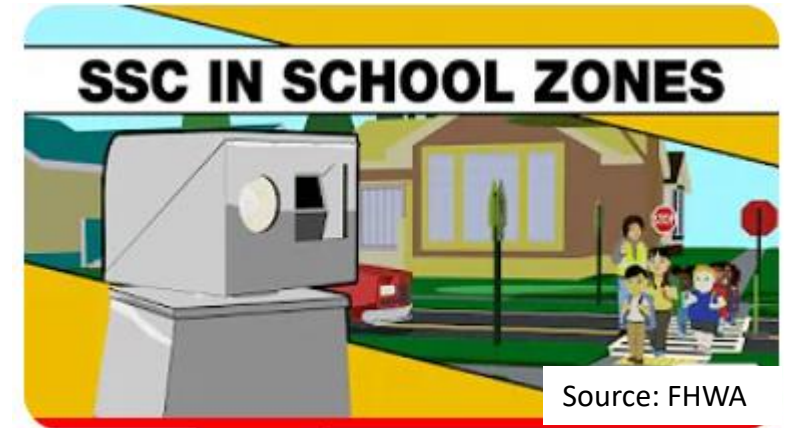
Source: FHWA

Case Studies and Resources



Case Studies

- Pennsylvania Automated Work Zone Speed Enforcement
 - Reduced average speeds by 2-8 mph
 - Reduced crashes by 15-50 percent
- Maryland SafeZones
 - 90 percent decrease in vehicles traveling 12-mph over the work zone speed limit
 - Reduced work zone crashes by 34 percent



Resources

- [USDOT Speed Safety Camera Operational Guide](#)
- [Speed Safety Cameras in School Zones video](#)



Source: Maryland SafeZones

Variable Speed Limits



Variable Speed Limits (VSL)



Applications



Considerations

- Particularly effective on:
 - Urban and rural freeways
 - High-speed arterials > 40 mph



Source: Ohio DOT



Opportunity for Widespread Deployment



- ✦ **22 States** use variable speed limits for either weather or congestion or both.
- ✦ **441 fatal motor vehicle crashes** in 2021 had a related crash factor of “recent/previous crash scene nearby,” indicating a potential **secondary crash**.
- ✦ The likelihood of a **secondary crash increases by 2.8% for each minute** the primary incident continues to be a hazard.



Source: Google Maps



Case Studies and Resources

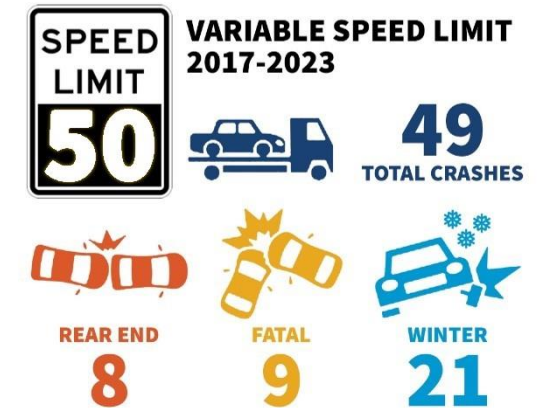
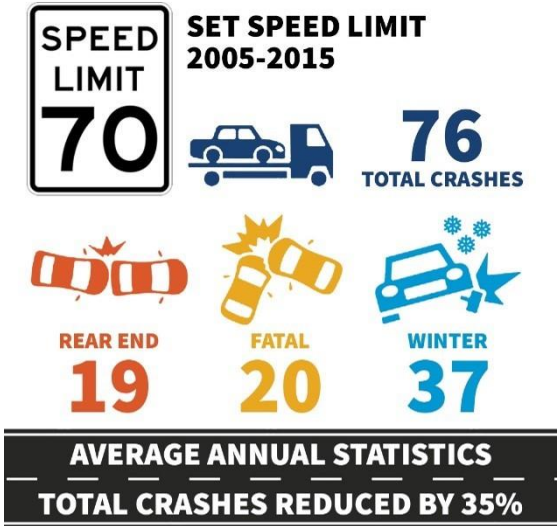


Case Studies

- [Pennsylvania Transform76](#) – several videos have been developed to explain the benefits of VSLs
- Minnesota – **7 percent increase** in throughput and **25-35 percent decrease** in speed variance from VSL implementation
- Ohio – 35% percent reduction in crashes along a segment on I-90 in Lake County

Resources

- [Guidelines for the Use of Variable Speed Limit Systems in Wet Weather](#)
- [Synthesis of Variable Speed Limit Signs](#)
- [Rural Intelligent Transportation Systems Toolkit – VSL](#)



Source: Ohio DOT



PSCs – Pedestrian/Bicyclist



Bicycle Lanes



Crosswalk Visibility Enhancements



Leading Pedestrian Interval



Medians and Pedestrian Refuge Islands in Urban and Suburban Areas



Pedestrian Hybrid Beacons



Rectangular Rapid Flashing Beacons (RRFB)



Road Diets (Roadway Reconfiguration)



Walkways



Bicycle Lanes



Bicycle Lanes



- ↳ Can be included on new or existing roadways
- ↳ Lane design should consider
 - Roadway characteristics (number of lanes, volumes, speed, presence of transit)
 - User needs (ridership, bicycle and micromobility types)
 - Land-use context (adjacent land use, types and intensity of conflicting uses, demands for curb access)
- ↳ Consider separated lanes using vertical elements (i.e. flexible delineator posts, curbs, vegetation) on higher volume and speed roadways



Source: DDOT



Source: City of Chicago

Effectiveness



- ▶ Up to **53% reduction** in bicycle vehicle crashes when converting traditional or flush buffered bicycle lanes to a Separated Bicycle Lane with flexible delineator posts (CMF ID 11296)
- ▶ Bike Lane Additions
 - Up to **49% reduction** in total crashes on urban 4-lane undivided collectors and local roads (CMF ID 10738)
 - Up to **30% reduction** in total crashes on urban 2-lane undivided collectors and local roads (CMF ID 10742)



Source: FHWA

Opportunity for Widespread Deployment



**2,850,000 miles of paved roadways in the US,
only 600 miles of separated bike lanes**



Source: FHWA

Case Studies and Resources



Case Studies

- New York City – evaluation of 150 miles of bike lanes
 - Reduced Fatalities and Serious Injuries by 18%
 - Reduced bicycling risk by 32%
 - Increased ridership by over 50%
- Colorado – Eagle Valley Trail consists of over 60 miles of paved pathways

$$\text{Bicyclist Risk} = \frac{\text{Bicyclist injuries per mile}}{\text{Estimated bicyclist volume}}$$

Resources

- [Bicycle and Pedestrian Planning, Program, and Project Development Guidance](#)
- [Bikeway Selection Guide](#)
- [BIKESAFE](#) – Bicycle Safety Guide and Countermeasure Selection System
- [Pedestrian and Bicyclist Road Safety Audit \(RSA\) Guide and Prompt Lists](#)
- [Primer on Safe System Approach for Pedestrians and Bicyclists](#)
- [Small Town and Rural Multimodal Networks](#)



Source: NYC DOT

Crosswalk Visibility Enhancements



Crosswalk Visibility Enhancements



- ◀ Improved intersection lighting
 - Place luminaires in forward locations
- ◀ High visibility crosswalks
 - Consider at all midblock and uncontrolled crossings
 - Use inlay or thermoplastic tape (instead of paint or brick)
- ◀ Advance Yield or Stop signage and markings
 - 20-50 feet in advance of marked crosswalk
 - Stop bar or Yield markings
 - Better sight lines to reduces multi-threat crashes
- ◀ See MUTCD for information on crosswalk markings ([Chapter 3C](#)) and in-street signing ([Sections 2B.19 and 2B.20](#))
- ◀ Table 1 of *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*

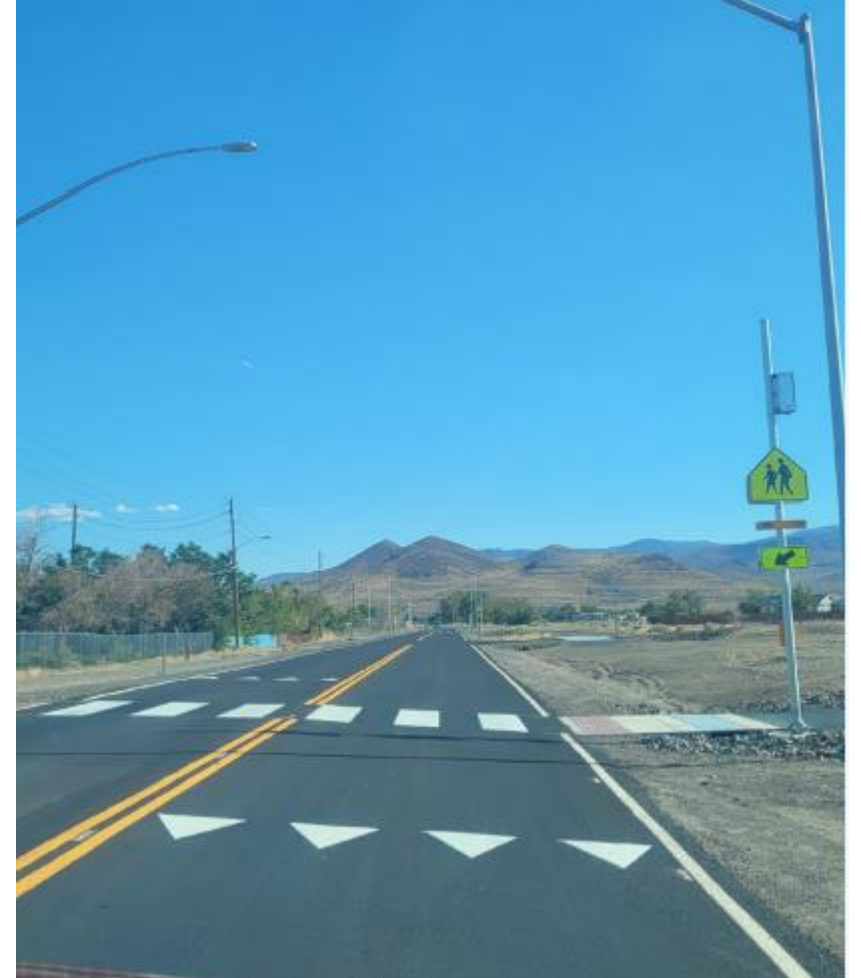


Source: FHWA

Effectiveness



- Intersection lighting
 - Up to **42% reduction** in pedestrian crashes (CMF ID 436)
- High-visibility crosswalks
 - Up to **40% reduction** in pedestrian injury crashes (CMF ID 4123)
- Advance yield or stop markings and signs
 - Up to **25% reduction** in pedestrian injury crashes (CMF ID 9017)



Source: FHWA

Opportunity for Widespread Deployment



Source: Peter Eun



Nighttime fatality rate on the Nation's roadways is **three times higher** than the daytime rate, and **76 percent** of pedestrian fatalities occur at **night**.



8.3% of occupied housing units have **no vehicles**.



There are approximately **19,000 school districts** (about **129,000 schools**) in the U.S.

Case Studies and Resources



Case Studies

- Flint Hills MPO (KS) – modified crosswalks with a multitude of quick-build techniques and demonstrations (e.g. curb extensions and pedestrian islands)
- Clark County (WA) – developed Crossing Treatment Decision Trees, Selection Tables, and Toolbox Cut Sheets



Clark County Pedestrian Crossings
ENHANCED CROSSING TREATMENT SELECTION TABLE - Figure 6

IF THE DECISION TREE OUTCOME WAS **CONSIDER ENHANCED CROSSING TREATMENT** THEN REFER TO THIS SELECTION TABLE

Resources

- [Pedestrian Lighting Primer](#)
- EDC [Nighttime Visibility for Safety initiative](#)
- [Safe Transportation for Every Pedestrian \(STEP\) – Crosswalk Visibility Enhancements Tech Sheet](#)
- [STEP Educational Video](#)
- [Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations](#)

RECOMMENDATIONS FOR MARKED CROSSWALKS AND ENHANCED PEDESTRIAN CROSSING TREATMENTS AT UNCONTROLLED LOCATIONS

ROADWAY TYPE (NUMBER OF TRAVEL LANES)	VEHICLE ADT > 4,000 TO 6,000			VEHICLE ADT > 6,000 TO 9,000			VEHICLE ADT > 9,000 TO 12,000			VEHICLE ADT > 12,000 TO 15,000			VEHICLE ADT > 15,000		
	SPEED LIMIT														
	≤ 30 MPH	35 MPH	≥ 40 MPH	≤ 30 MPH	35 MPH	≥ 40 MPH	≤ 30 MPH	35 MPH	≥ 40 MPH	≤ 30 MPH	35 MPH	≥ 40 MPH	≤ 30 MPH	35 MPH	≥ 40 MPH
2 Lanes	A	A	B	B	B	B	B	B	B	B	E	B	B	E	
3 Lanes	A	A	B	C	C	D	C	D	D	C	D	E	D	E	
Multi-Lane (4 or more Lanes)	C	C	C	C	C	D	C	D	E	D	D	E	D	E	

NOTES:

* Shared-use path crossing locations with ADT less than 4,000 ADT may qualify for marked crosswalks and/or enhanced pedestrian crossing treatments as shown in the column for "Vehicle ADT > 4,000 to 6,000."

* Installation of marked crosswalk or enhanced crossing treatment, at any location, subject to engineering study and judgement that accounts for factors such as sight distance, traffic safety, traffic operations, other field conditions and pedestrian population. The engineering study must include a site-specific delay analysis, using the HCM.

LEGEND

- A Marked Crosswalk
- B Marked Crosswalk with Flashing Beacon
- C Marked Crosswalk with Median Island
- D Marked Crosswalk with Flashing Beacon and Median Island
- E Marked Crosswalk with Pedestrian Hybrid Beacon (PHB) or Traffic Signal

REFERENCES:

- * Zegeer, Steward, Huang, "Safety Effects of Marked vs Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines", FHWA, 2002.
- * Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition, published by FHWA.
- * Highway Capacity Manual (HCM), 2016 sixth edition, published by TRB.

Source: Clark County (WA)

Leading Pedestrian Interval



Leading Pedestrian Interval (LPI)



- ↳ Provides pedestrians 3-7 second head start in crosswalk
- ↳ Reduce conflicts between pedestrians and vehicles
- ↳ Improve visibility of pedestrians in the crosswalk
- ↳ Increased likelihood of driver yielding
- ↳ Enhanced safety for slower moving pedestrians
- ↳ Agencies that prioritize intersections, consider the following factors:
 - Crash history
 - Pedestrian crossing volumes
 - Vulnerable populations
 - One-way streets or at T-intersections
 - Intersection Visibility
- ↳ Very low cost – only require adjustments to the signal
- ↳ MUTCD [Section 4I.06](#)



Source: FHWA

Effectiveness



↳ Up to **13% reduction** in pedestrian-vehicle crashes at intersections (CMF ID 9918)



Source: City of Toronto



Source: FHWA

Opportunity for Widespread Deployment



There are approximately **300,000 traffic signals** in the U.S.



84% of pedestrian fatalities in 2021 occurred in **urban** areas.



23% of pedestrian fatalities in 2021 occurred at **intersections**.



Source: FHWA

Case Studies and Resources



Case Studies

- City of Austin (TX) – implemented LPIs at 110 of 135 downtown signalized intersections
 - Level of effort (12 person-hours)
 - Survey: 87% felt safer crossing at an intersection with an LPI, 60% more likely to use a crosswalk knowing it has an LPI
- Seattle DOT (WA) – policy requires evaluation of LPI for all new signals and all signal maintenance
 - Installed 527 LPIs (50% of traffic signals citywide as of 1/1/23)
 - 48% reduction in pedestrian turning collisions and 34% reduction in fatal and serious injury pedestrian collisions

Resources

- [Safe Transportation for Every Pedestrian \(STEP\) – LPI Tech Sheet](#)
- [STEP Educational Video](#)
- [PEDSAFE – LPI](#)
- [NACTO Urban Street Design Guide](#)
- [Caltrans – Implementation Guidelines](#)



Source: Seattle DOT

PSCs – Intersection



Backplates with Retroreflective Borders



Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections



Yellow Change Intervals



Reduced Left-Turn Conflict Intersections



Roundabouts

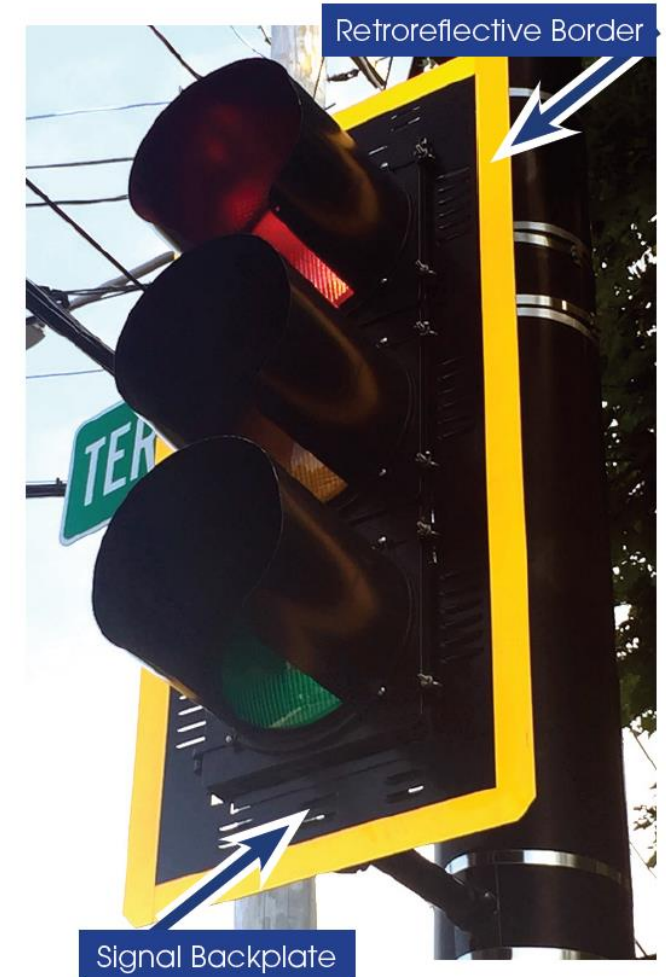
Backplates with Retroreflective Borders



Backplates with Retroreflective Borders



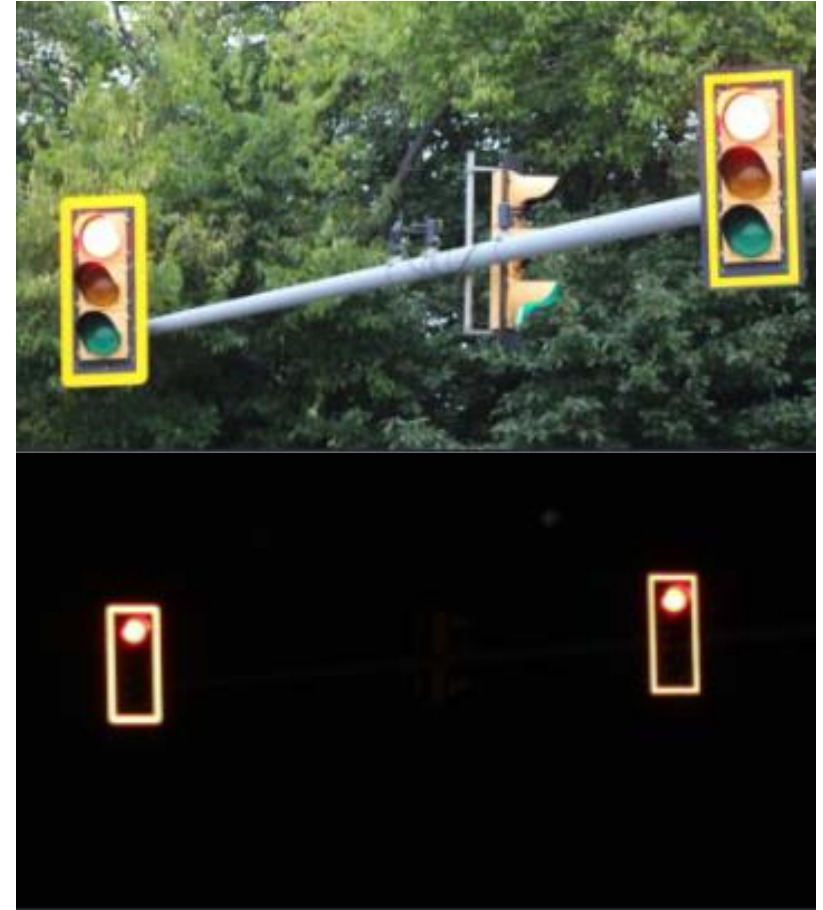
- Improve visibility of the illuminated face of the signal via a controlled-contrast background
- 1- to 3-inch yellow retroreflective border
- Benefits during both daytime and nighttime, and during power outages
- Consider additional wind load when designing and evaluating signal supports
- Very low cost
- Adopt as standard treatment



Source: FHWA



↳ Up to **15% reduction** in total crashes (CMF ID 1410)



Source: VDOT

Opportunity for Widespread Deployment



← There are **200,000 red-light running crashes** per year.

← **10 to 15 minutes** for installation per backplate.



← As of 2014, **more than half** of State highway agencies had a policy, specification, or standard for implementing backplates with retroreflective borders.



← **Backplates should be considered for all roads with speeds 40 mph and up** based on engineering judgement to accommodate aging population and help promote signal visibility.



Source: Nevada DOT



Case Studies

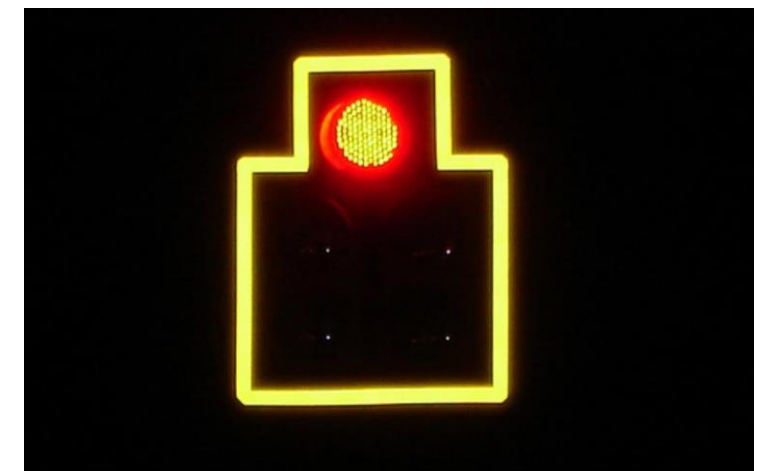
- City of Nashua (NH) – project to upgrade 68 intersections
 - 2-inch strip of yellow reflective tape on approximately 400 signal heads
 - 13% reduction in total crashes due to retroreflective backplates, improved intersection levels of service
- Kentucky Transportation Cabinet (KYTC) – project to upgrade 30 signalized intersections
 - 44% reduction in angle crashes
 - 10% reduction in rear-end crashes
- South Carolina DOT – evaluation of 3 intersections
 - 28% reduction in total crashes
 - 36% reduction in injury crashes
 - 49% reduction in late-night/early morning crashes after the installation

Resources

- [Technical Summary: Backplates with Retroreflective Borders](#)



Source: City of Nashua (NH)



Source: South Carolina DOT

Reduced Left-Turn Conflict Intersections

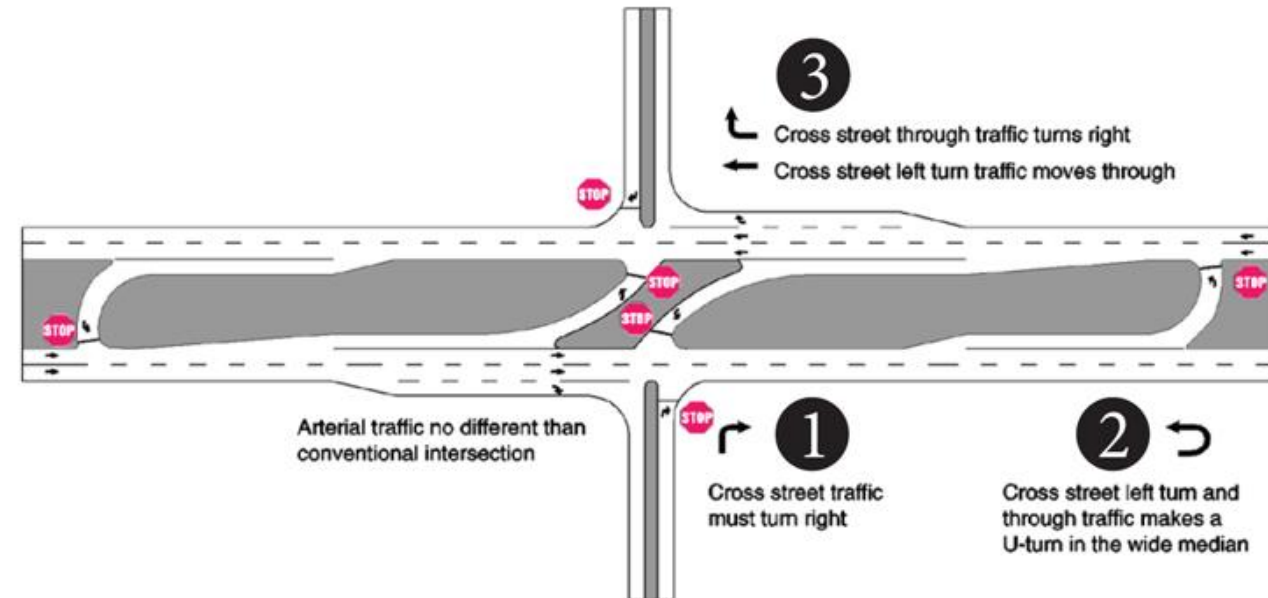


Reduced Left-Turn Conflict Intersections

Restricted Crossing U-Turn (RCUT)



- ↳ Also known as J-Turn, Superstreet, or Reduced Conflict Intersection
- ↳ Modifies left turn and through movements from cross streets
- ↳ Minor road traffic makes right turn followed by a U-turn at a designated location
- ↳ Adaptable and less costly than an interchange
- ↳ 30% increase in throughput and 40% reduction in intersection travel time



Example of a Restricted Crossing U-Turn (RCUT) intersection.

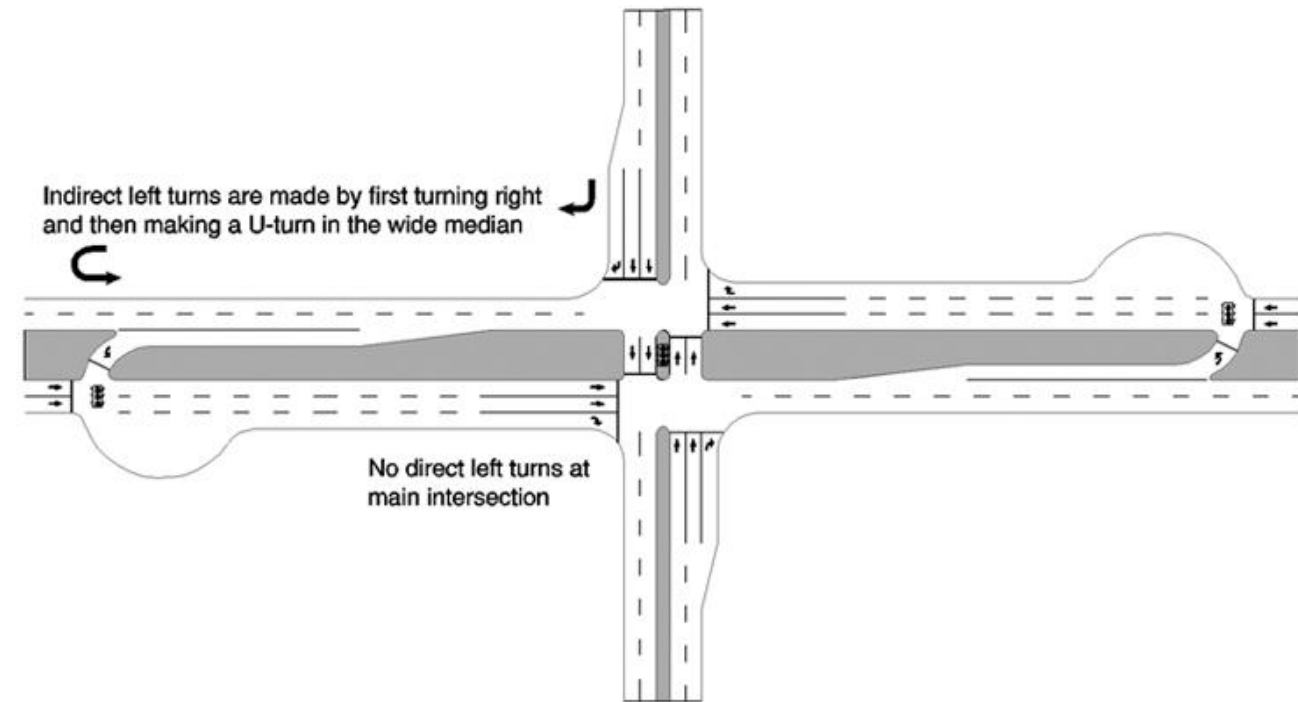
Source: FHWA

Reduced Left-Turn Conflict Intersections

Median U-Turn (MUT)



- Also known as Indirect Left or Michigan Left Intersection
- Modifies left turn from major approaches
- Major road traffic proceeds through the main intersection, makes a U-turn a short distance downstream, followed by a right turn at the main intersection
- U-turns can also be used for modifying the cross-street left turns, similar to the RCUT



Example of a Median U-Turn (MUT) intersection.
Source: FHWA



↙ Two-way Stop-Controlled to RCUT

- Up to **54% reduction** in fatal and injury crashes (CMF ID 5556)

↙ Signalized Intersection to Signalized RCUT

- Up to **22% reduction** in fatal and injury crashes (CMF ID 9985)

↙ Unsignalized Intersection to Unsignalized RCUT

- Up to **63% reduction** in fatal and injury crashes (CMF ID 4884)

↙ Median U-turn

- Up to **30% reduction** in intersection-related injury crash rate (CMF ID 10867)



Source: FHWA

Opportunity for Widespread Deployment



- ✦ **50 percent** of fatal crashes at **intersections** are **angle crashes**.
- ✦ **No evidence of declining sales** at surrounding businesses from installing RCUTs (based on a Louisiana study).
- ✦ North Carolina is leading the nation with **> 100 RCUTs**.
- ✦ Michigan has over 425 miles with **> 700 directional crossovers** on the State highway system.



Source: North Carolina DOT



Case Studies

- Maryland SHA – installed six RCUTS along US 15
 - 4-lane divided highway, several minor road intersections
 - 40% reduction in injury crashes
 - 70% reduction in fatal crashes
- Indiana DOT – evaluated seven Reduced Left-Turn Conflict Intersections
 - 81% reduction in fatal and injury crashes

Resources

- [FHWA Reduced Left-Turn Conflict Intersections Webpage](#)
- [RCUT Informational Guide](#)
- [MUT Informational Guide](#)



Source: FHWA (MD RCUT)



Source: Indiana DOT

Systemic Application of Multiple Low-Cost Countermeasures at Stop- Controlled Intersections



Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections



- ↳ Increase driver awareness and recognition of intersections and potential conflicts
- ↳ On the Through Approach
 - Doubled-up (left and right) signs
 - Oversized advance intersection warning signs with supplemental street name plaques
 - Flashing beacons
 - Retroreflective sheeting on sign posts
 - Enhanced pavement markings
- ↳ On the Stop Approach
 - Doubled-up (left and right) signs
 - Oversized advance “Stop Ahead” intersection warning signs
 - Flashing beacons
 - Retroreflective sheeting on sign posts
 - Properly placed stop bar
 - Sight distance improvements
 - Double arrow warning sign at stem of T-intersections



Source: South Carolina DOT

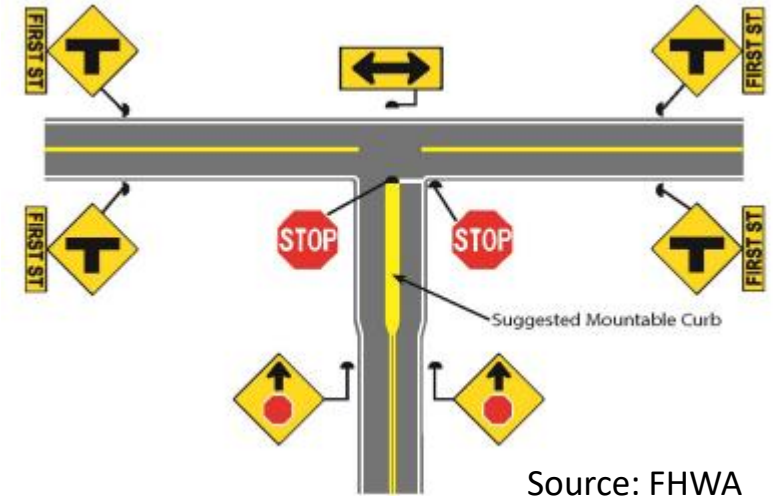


Source: South Carolina DOT

Effectiveness



- ↳ Up to **10% reduction** of fatal and injury crashes at all locations/types/areas (CMF ID 8867)
- ↳ Up to **15% reduction** of nighttime crashes at all locations/types/areas (CMF ID 8870)
- ↳ Up to **27% reduction** of fatal and injury crashes at rural intersections (CMF ID 8874)
- ↳ Up to **19% reduction** of fatal and injury crashes at 2-lane by 2-lane intersections (CMF ID 8893)
- ↳ Low-cost – Average B/C ratio 12:1



Source: FHWA



Source: Sisseton Wahpeton Oyate Tribe

Opportunity for Widespread Deployment



- ▶ **25% of all traffic fatalities and 50% of all injuries** occur at **intersections**.
- ▶ Roughly **68% of total intersection fatalities** occur at **unsignalized intersections** (including over 1,000 pedestrian fatalities).



Source: FHWA

Case Studies and Resources



Case Studies

- Louisiana DOTD – installed low-cost safety treatments at 89 stop-controlled intersections
 - 56% reduction of fatal and injury crashes at 3-legged intersections
 - 64% reduction of fatal and injury crashes at 4-legged intersections
- South Carolina DOT - systemic implementation of low-cost countermeasures at stop-controlled intersections
 - 27% reduction of fatal and injury crashes
 - 25% reduction of total crashes at rural intersections

Resources

- [FHWA Stop-Controlled Intersections Webpage](#)
- [Technical Summary: Systemic Application of Multiple Low-Cost Countermeasures for Stop-Controlled Intersections](#)



Source: Acadiana Planning Commission



Source: South Carolina DOT

Yellow Change Intervals



Yellow Change Intervals



- ◀ Warn drivers of impending change in right-of-way assignment
- ◀ Proper Timing is important
 - See the MUTCD Section 4F.17
- ◀ Interval timing should consider:
 - Speed of approaching and turning vehicles
 - Driver perception-reaction time
 - Vehicle deceleration
 - Intersection geometry
- ◀ Automated traffic signal performance measures (ATSPMs)
 - Continuous performance monitoring capability
 - Modify timing based on actual performance, without requiring expensive modeling or data collection



Source: FHWA

Effectiveness



- ↳ Up to **36-50% reduction** in red light running
- ↳ Up to **8-14% reduction** in total crashes (CMF ID 380)
- ↳ Up to **12% reduction** in injury crashes (CMF ID 384)



Source: FHWA

Opportunity for Widespread Deployment

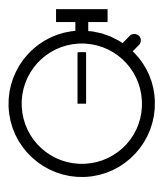


↳ An estimated **165,000 injuries involve red-light running** annually (motorists, cyclists, and pedestrians).

↳ In a 2009 survey with **247 total respondents across 49 States:**



60% did not have a formal policy for timing traffic signal change intervals.



72% reported minimum yellow timing values of 3 seconds.

77% reported maximum yellow timing values ≥ 5 seconds.



Source: Idaho Transportation Department



Case Studies

- Connecticut DOT – initiated project to evaluate yellow change intervals for hundreds of municipally-owned traffic signals
- City of Albuquerque (NM) – evaluated yellow change intervals improvements at 18 intersections
 - 8% reduction in total crashes
 - 18% decrease in angle crashes

Resources

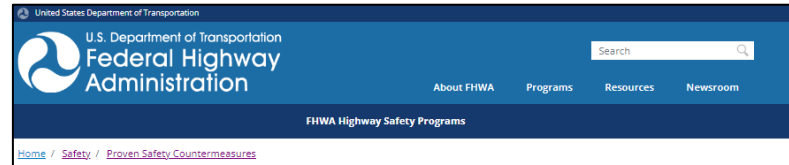
- [FHWA Signalized Intersections Webpage](#)
- [Signalized Intersection Informational Guide](#)
- [MUTCD Section 4F.17](#)



Source: CTDOT

Tools for Practitioners

<https://highways.dot.gov/safety/proven-safety-countermeasures>



- Proven Safety Countermeasures
- Search Safety Proven Countermeasures
- Resources

Proven Safety Countermeasures
 FHWA's Proven Safety Countermeasures initiative (PSC) is a collection of 28 countermeasures and strategies effective in reducing roadway fatalities and serious injuries on our Nation's highways. Transportation agencies are strongly encouraged to consider widespread implementation of PSCs to accelerate the achievement of local, State, and National safety goals. These strategies are designed for all road users and all kinds of roads—from rural to urban, from high-volume freeways to less traveled two-lane State and county roads, from signalized crossings to horizontal curves, and everything in between. Each countermeasure addresses at least one safety focus area - speed management, intersections, roadway departures, or pedestrians/bicyclists - while others are crosscutting strategies that address multiple safety focus areas. [Search Proven Safety Countermeasures.](#)

- Speed Management**
- Appropriate Speed Limits for All Road Users
- Pedestrian/Bicyclist**
- Bicycle Lanes
 - Medians and Pedestrian Refuge Islands in Urban and Suburban Areas
 - Road Diets (Roadway Configuration)

Proven Safety Countermeasures Filter Tool and Keyword Search

All 28 PSCs are listed at the bottom of the page in alphabetical order. Answer one or more of the following questions to obtain a tailored listing of potential PSCs for the location of interest. Users may select multiple answers for each question. After checking the desired box(es), click "Apply", then the list of PSCs will update at the bottom of the page to match the query. Click "Reset" to remove all filters or keywords and return to the default display of all 28 PSCs. Select a countermeasure name to learn more including a description, safety effectiveness, context, application, cost, and considerations for implementation.

Roadway Area Type Urban Suburban Rural	Roadway Classification Freeway Highway Arterial Collector Local	Focus Area Speed Management Pedestrian/Bicyclist Roadway Departure Intersections Crosscutting
Average Annual Daily Traffic Vehicular Volume Low (< 2,000) Medium (2,000-15,000) High (> 15,000)	Problem(s) to be Addressed Inadequate Visibility, Con Excessive Vehicular Confi Congestion Excessive Speeds Non-Compliance (yielding No Separation of Users Vulnerable Users not Cor Driver Inattention (distrac	Crash Type(s) Being Targeted Angle Left-Turn Right-Turn Rear End Pedestrian/Bicyclist Head On Run-Off-Road/Single Vehi Sideswipe, same directio

Search PSCs by Keyword(s)



Source: FHWA

Source: FHWA

Prioritizing Locations – Vision Zero Philadelphia

Frankford Avenue, Trenton Avenue, and York Street intersection (Philadelphia, PA)



Source: Philadelphia Inquirer



Source: Google Maps



Implementing Solutions



Source: McCormick Taylor



Source: McCormick Taylor



Source: City of Philadelphia



Where to Start



- Assess the implementation status of PSCs
- Review SHSP emphasis areas
- Identify Projects
 - Review and leverage existing information in network screening lists, safety action plans, bicycle and pedestrian plans, HSIP Implementation Plans, safety improvement candidate or prioritization lists
- 23 U.S.C. 120(c)(1) – certain safety projects (including many PSCs) eligible for 100% Federal share

We are here to help!

FUNDING SAFETY FOR ALL.

FHWA encourages implementation of projects and programs that improve safety, equity, and accessibility for all road users. Take the first step toward exploring federal funding opportunities for your Complete Streets Network.

- | | | |
|--|--|--|
| <u>Federal Transit Administration Grant Programs</u> | <u>Tribal Transportation Program</u> | <u>Tribal Transportation Program Safety Fund</u> |
| <u>National Highway Performance Program</u> | <u>Metropolitan Planning Funds</u> | ATTAIN |
| <u>Surface Transportation Block Grant Program</u> | PROTECT | <u>RAISE Discretionary Grants</u> |
| <u>Bridge Replacement and Rehabilitation Program</u> | <u>Railway-Highway Crossing Program</u> | INFRA Grants |
| <u>Highway Safety Improvement Program</u> | <u>Statewide Planning and Research</u> | <u>Safe Streets and Roads for All Grants</u> |
| <u>Congestion Mitigation and Air Quality Improvement Program</u> | <u>Recreational Trails Program</u> | <u>Transit Oriented Development</u> |
| <u>Bridge Investment Program</u> | <u>Bridge Formula Program</u> | <u>Reconnecting Communities Pilot Program</u> |
| <u>Transportation Alternatives</u> | <u>Railroad Rehabilitation & Improvement Financing</u> | <u>Areas of Persistent Poverty Program</u> |
| <u>Carbon Reduction Program</u> | <u>TIFIA Program</u> | <u>National Scenic Byways Program</u> |
| | <u>Federal Lands and Tribal Transportation Programs</u> | <u>Active Transportation Infrastructure Investment Program</u> |

FUNDING SAFETY FOR ALL.

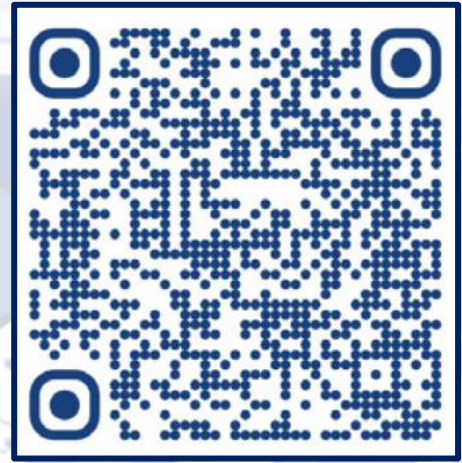
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Interested in learning more? Visit the FHWA Complete Streets Funding site: <https://highways.dot.gov/complete-streets/make-complete-streets-default-approach>. In addition to funding, FHWA provides guidance, technical assistance, and other resources to improve safety in projects, policies, and procedures.

2023

Thank You!



Mark Doctor, PE
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SCAN ME!



U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE